CLAIMS

1. A sputtering target used for forming a barrier layer relative to a copper-containing material and comprising Ti and one or more alloying elements which have a standard electrode potential of less than about -1.0V.
2. The sputtering target of claim 1 wherein the copper-containing material is a copper-based material.
3. The sputtering target of claim 1 comprising at least one alloying elements which does not have the standard electrode potential of less than about -1.0V.
4. The sputtering target of claim 1 wherein the only alloying elements in the sputtering target are elements having the standard electrode potential of less than about -1.0V.
5. The sputtering target of claim 1 wherein the one or more alloying elements are selected from the group consisting of Be, B, Al, Si, Ca, Sc, V, Cr, Mn, Fe, Sr, Y, Zr, Cs, Ba, La, Hf, Ta, Ce, Pr, Nd, Sm, Gd, Dy, Ho and Er.
6. The sputtering target of claim 1 wherein the one or more alloying elements are selected from the group consisting of Be, Ca, Sr and Ba.
7. The sputtering target of claim 1 wherein the one or more alloying elements comprise Zr.
8. The sputtering target of claim 1 wherein the one or more alloying elements comprise B.
9. The sputtering target of claim 1 wherein the one or more alloying elements comprise Hf.
10. The sputtering target of claim 1 wherein the one or more alloying elements comprise V.
11. The sputtering target of claim 1 wherein the one or more alloying elements comprise Cr.
12. The sputtering target of claim 1 wherein the one or more alloying elements comprise Mn.

13. The sputtering target of claim 1 wherein the one or more alloying elements comprise Fe.

14. The sputtering target of claim 1 wherein the one or more alloying elements comprise Al.

15. A sputtering target used for forming a barrier layer relative to a Cu-containing material and comprising Ti and one or more alloying elements having at least a 8 percent difference in atomic radii relative to titanium.

16. The sputtering target of claim 15 wherein the one or more alloying elements are selected from the group consisting of Al, Ca, Mn, Fe, Co, Ni, Y, Zr and Hf.

17. The sputtering target of claim 15 wherein the one or more alloying elements comprise Co.

18. The sputtering target of claim 15 wherein the one or more alloying elements comprise Ni.

19. The sputtering target of claim 15 wherein the one or more alloying elements comprise Y.

20. A sputtering target used for forming a barrier layer relative to a Cu-containing material and comprising Ti and one or more alloying elements having at least a 20 percent difference in atomic radii relative to titanium.

21. The sputtering target of claim 20 wherein the one or more alloying elements are selected from the group consisting of Be, B, C, Si, P, S, Cs, Ba, La, Ce, Pr, Nd, Sm, Gd, Dy, Ho, Er and Yb.

22. The sputtering target of claim 20 wherein the one or more alloying elements are selected from the group consisting of Ce, Pr, Nd, Sm, Gd, Dy, Ho, Er and Yb.

23. The sputtering target of claim 20 wherein the one or more alloying elements comprise Ba.

24. The sputtering target of claim 20 wherein the one or more alloying elements comprise La.

25. The sputtering target of claim 20 wherein the one or more alloying elements comprise Yb.

26. A sputtering target used for forming a barrier layer relative to a Cu-containing material and comprising Ti and one or more alloying elements which have a melting temperature of at least about 2400°C.

27. The sputtering target of claim 26 wherein the one or more alloying elements are selected from the group consisting of C, Nb, Mo, Ta and W.

28. The sputtering target of claim 26 wherein the one or more alloying elements comprise Nb.

29. The sputtering target of claim 26 wherein the one or more alloying elements comprise Mo.

30. The sputtering target of claim 26 wherein the one or more alloying elements comprise Ta.

31. The sputtering target of claim 26 wherein the one or more alloying elements comprise W.

32. A sputtering target consisting essentially of Ti and Zr; and containing less than 12 atomic percent Zr.

33. The sputtering target of claim 32 containing less than 8 atomic percent Zr.

34. The sputtering target of claim 32 containing less than 6 atomic percent Zr.

35. The sputtering target of claim 32 containing less than 2 atomic percent Zr.

36. The sputtering target of claim 32 containing from 2 atomic percent to less than 12 atomic percent Zr.

37. A sputtering target comprising Ti and one or more alloying elements which have a standard electrode potential of less than about -1.0V; said sputtering target not including binary alloys of TiAl and TiSi; and further not including binary alloys of TiZr in which Zr is present in the range of 12-18 atom% or in the range of 32-38 atom%.

38. The sputtering target of claim 37 wherein the one or more alloying elements are selected from the group consisting of Be, B, Ca, Sc, V, Cr, Mn, Fe, Sr, Y, Cs, Ba, La, Hf, Ta, Ce, Pr, Nd, Sm, Gd, Dy, Ho and Er.

39. The sputtering target of claim 37 wherein the one or more alloying elements are selected from the group consisting of Be, Ca, Sr and Ba.

40. The sputtering target of claim 37 wherein the one or more alloying elements comprise B.

41. The sputtering target of claim 37 wherein the one or more alloying elements comprise Hf.

42. The sputtering target of claim 37 wherein the one or more alloying elements comprise V.

43. The sputtering target of claim 37 wherein the one or more alloying elements comprise Cr.

44. The sputtering target of claim 37 wherein the one or more alloying elements comprise Mn.

45. The sputtering target of claim 37 wherein the one or more alloying elements comprise Fe.

46. A sputtering target comprising Ti and one or more alloying elements having at least a 8 percent difference in atomic radii relative to titanium; said sputtering target not including binary complexes of Ti and alloying elements selected from the group consisting of Al and Si; said sputtering target also not including binary complexes of Ti and Zr in which Zr is present in the range of 12-18 atom% or in the range of 32-38 atom%.

47. The sputtering target of claim 46 wherein the one or more alloying elements are selected from the group consisting of Ca, Mn, Fe, Co, Ni, Y, and Hf.

48. The sputtering target of claim 46 wherein the one or more alloying elements comprise Y.

49. The sputtering target of claim 46 wherein the one or more alloying elements comprise Co.

50. The sputtering target of claim 46 wherein the one or more alloying elements comprise Ni.

51. The sputtering target of claim 46 wherein the one or more alloying elements have a difference in atomic radii of at least 20% relative to Ti.

52. The sputtering target of claim 51 wherein the one or more alloying elements are selected from the group consisting of Be, B, C, P, S, Cs, Ba, La, Ce, Pr, Nd, Sm, Gd, Dy, Ho, Er and Yb.

53. The sputtering target of claim 51 wherein the one or more alloying elements are selected from the group consisting of Ce, Pr, Nd, Sm, Gd, Dy, Ho, Er and Yb.

54. The sputtering target of claim 51 wherein the one or more alloying elements comprise Ba.

55. The sputtering target of claim 51 wherein the one or more alloying elements comprise La.

56. The sputtering target of claim 51 wherein the one or more alloying elements comprise Yb.

57. A sputtering target comprising Ti and one or more alloying elements which have a melting temperature of at least about 2400°C; said sputtering target not including binary alloys of Ti and W in which W is the range of 35-50 atom %; said sputtering target also not including binary alloys of Ti and Nb in which Nb is the range of 6-8 atom %.

58. The sputtering target of claim 57 wherein the one or more alloying elements are selected from the group consisting of C, Mo, and Ta.

59. The sputtering target of claim 57 wherein the one or more alloying elements comprise Mo.

60. The sputtering target of claim 57 wherein the one or more alloying elements comprise Ta.

61. A sputtering target used for forming a barrier layer relative to a silver-containing material and comprising Ti and one or more alloying elements having at least one of: (1) a standard electrode potential of less than about -1.0V; (2) a melting temperature of at least about 2400°C; or (3) at least a 8 percent difference in atomic radii relative to titanium.

62. The sputtering target of claim 61 wherein the one or more alloying elements comprise Zr.

63. A sputtering target used for forming a barrier layer relative to an aluminum-containing material and comprising Ti and one or more alloying elements having at least one of: (1) a standard electrode potential of less than about -1.0V; (2) a melting temperature of at least about 2400°C; or (3) at least a 8 percent difference in atomic radii relative to titanium.

64. The sputtering target of claim 63 wherein the one or more alloying elements comprise Zr.

65. A means for forming a Cu barrier layer by sputter-depositing a film from a target comprising Ti and one or more alloying elements selected from the group consisting of Be, B, Al, Si, Ca, Sc, V, Cr, Mn, Fe, Sr, Y, Zr, Cs, Ba, La, Hf, Ta, Ce, Pr, Nd, Sm, Gd, Dy, Ho and Er.

66. The means of claim 65 wherein the one or more alloying elements comprise Zr.

67. The means of claim 65 wherein the one or more alloying elements comprise V.

68. The means of claim 65 wherein the one or more alloying elements comprise Cr.

69. The means of claim 65 wherein the one or more alloying elements comprise Mn.

70. The means of claim 65 wherein the one or more alloying elements comprise Fe.

71. The means of claim 65 wherein the one or more alloying elements comprise Al.

72. A method of inhibiting copper diffusion into a substrate, comprising:

forming a first layer comprising Ti and one or more alloying elements over the substrate, the one or more alloying elements having a difference in atomic radii relative to Ti of at least 8%; and

forming a copper-containing layer over the first layer; the first layer inhibiting copper diffusion from the copper-containing layer to the substrate.

73. The method of claim 72 wherein the copper-containing layer is a copper-based layer.

74. The method of claim 72 wherein the one or more alloying elements are selected from the group consisting of Al, Ca, Mn, Fe, Co, Ni, Y, Zr and Hf.

75. The method of claim 72 wherein the one or more alloying elements comprise Y.

76. The method of claim 72 wherein the one or more alloying elements have a difference in atomic radii of at least 20% relative to Ti.

77. The method of claim 76 wherein the one or more alloying elements are selected from the group consisting of Be, B, C, Si, P, S, Cs, Ba, La, Ce, Pr, Nd, Sm, Gd, Dy, Ho, Er and Yb.

78. The method of claim 76 wherein the one or more alloying elements comprise Ba.

79. The method of claim 76 wherein the one or more alloying elements comprise La.

80. The method of claim 76 wherein the one or more alloying elements comprise Yb.

81. A method of inhibiting copper diffusion into a substrate, comprising:

forming a first layer comprising Ti and one or more alloying elements which have a standard electrode potential of less than about -1.0V over the substrate; and

forming a copper-containing layer over the first layer; the first layer inhibiting copper diffusion from the copper-containing layer to the substrate.

82. The method of claim 81 wherein the one or more alloying elements are selected from the group consisting of Be, B, Al, Si, Ca, Sc, V, Cr, Mn, Fe, Sr, Y, Zr, Cs, Ba, La, Hf, Ta, Ce, Pr, Nd, Sm, Gd, Dy, Ho and Er.

83. The method of claim 81 wherein the layer consists essentially of the Ti and the one or more alloying elements.

84. The method of claim 81 wherein the layer consists of the Ti and the one or more alloying elements.

85. The method of claim 81 wherein the one or more alloying elements comprise Zr.

86. The method of claim 81 wherein the one or more alloying elements comprise V.

87. The method of claim 81 wherein the one or more alloying elements comprise Cr.

88. The method of claim 81 wherein the one or more alloying elements comprise Mn.

89. The method of claim 81 wherein the one or more alloying elements comprise Fe.

90. The method of claim 81 wherein the one or more alloying elements comprise Al.

91. The method of claim 81 wherein the first layer is formed by sputter deposition from a target comprising the Ti and the one or more alloying elements which have a standard electrode potential of less than about -1.0V.

92. A thin film of $Ti_xQ_yN_z$ inhibiting copper diffusion from a copper-containing material and formed by sputtering a sputtering target in a nitrogen atmosphere, wherein "Q" is a label for said one or more alloying elements; said target comprising Ti and one or more alloying elements which have a standard electrode potential of less than about -1.0V.

93. The thin film of claim 92 wherein $x=0.1\text{-}0.7$, $y=0.001\text{-}0.3$, and $z=0.1\text{-}0.6$.

94. The thin film of claim 92 having a thickness of from about 2 nm to about 50nm.

95. The thin film of claim 92 having a thickness of from about 2 nm to about 20nm.

96. The thin film of claim 92 further comprising an electrical resistivity of equal to or less than 300$\mu\Omega$•cm.

97. The $Ti_xQ_yN_z$ thin film of claim 92 used as a Cu barrier layer in a microelectronic device.

98. The thin film of claim 92 further comprising a mean grain size of equal to or less than 100nm, the mean grain size remaining equal to or less than 100nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

99. The thin film of claim 92 further comprising a mean grain size of equal to or smaller than 10nm, the mean grain size remaining equal to or less than 10nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

100. The thin film of claim 92 further comprising a mean grain size of equal to or smaller than 1nm, the mean grain size remaining equal to or less than 1nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

101. A thin film of $Ti_xQ_yN_zO_w$ inhibiting copper diffusion from a copper-containing material and formed by sputtering a sputtering target in the presence of a nitrogen-containing gas and an oxygen-containing gas, wherein "Q" is a label for said one or more alloying elements; said target comprising Ti and one or more alloying elements which have a standard electrode potential of less than about -1.0V.

102. The thin film of claim 101 wherein x=0.1-0.7, y=0.001-0.3, z=0.1-0.6, and w=0.0001-0.0010.

103. The thin film of claim 101 having a thickness of from about 2 nm to about 50nm.

104. The thin film of claim 101 having a thickness of from about 2 nm to about 20nm.

105. The thin film of claim 101 further comprising an electrical resistivity of equal to or lower than 300μΩ•cm.

106. The thin film of claim 101 further comprising a mean grain size of equal to or less than 100nm, the mean grain size remaining equal to or less than 100nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

107. The thin film of claim 101 further comprising a mean grain size of equal to or smaller than 10nm, the mean grain size remaining equal to or less than 10nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

108. The thin film of claim 101 further comprising a mean grain size of equal to or smaller than 1nm, the mean grain size remaining equal to or less than 1nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

109. The $Ti_xQ_yN_zO_w$ thin film of claim 101 used as a Cu barrier layer in a microelectronic device.

110. A thin film of $Ti_xQ_yN_z$ inhibiting copper diffusion from a copper-containing material and formed by sputtering a sputtering target in a nitrogen atmosphere, wherein "Q" is a label for said one or more alloying elements; said target comprising Ti and one or more alloying elements which have a melting temperature of at least about 2400°C.

111. The thin film of claim 110 wherein x=0.1-0.7, y=0.001-0.3, and z=0.1-0.6.

112. The thin film of claim 110 having a thickness of from about 2 nm to about 50nm.

113. The thin film of claim 110 having a thickness of from about 2 nm to about 20nm.

114. The thin film of claim 110 further comprising an electrical resistivity of equal to or less than 300μΩ•cm.

115. The $Ti_xQ_yN_z$ thin film of claim 110 used as a Cu barrier layer in a microelectronic device.

116. The thin film of claim 110 further comprising a mean grain size of equal to or less than 100nm, the mean grain size remaining equal to or less than 100nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

117. The thin film of claim 110 further comprising a mean grain size of equal to or smaller than 10nm, the mean grain size remaining equal to or less than 10nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

118. The thin film of claim 110 further comprising a mean grain size of equal to or smaller than 1nm, the mean grain size remaining equal to or less than 1nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

119. A thin film of $Ti_xQ_yN_zO_w$ inhibiting copper diffusion from a copper-containing material and formed by sputtering a sputtering target in the presence of a nitrogen-containing gas and an oxygen-containing gas, wherein "Q" is a label for said one or more alloying elements; said target comprising Ti and one or more alloying elements which have a melting temperature of at least about 2400°C.

120. The thin film of claim 119 wherein x=0.1-0.7, y=0.001-0.3, z=0.1-0.6, and w=0.0001-0.0010.

121. The thin film of claim 119 having a thickness of from about 2 nm to about 50nm.

122. The thin film of claim 119 having a thickness of from about 2 nm to about 20nm.

123. The thin film of claim 119 further comprising an electrical resistivity of equal to or lower than 300μΩ•cm.

124. The thin film of claim 119 further comprising a mean grain size of equal to or less than 100nm, the mean grain size remaining equal to or less than 100nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

125. The thin film of claim 119 further comprising a mean grain size of equal to or smaller than 10nm, the mean grain size remaining equal to or less than 10nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

126. The thin film of claim 119 further comprising a mean grain size of equal to or smaller than 1nm, the mean grain size remaining equal to or less than 1nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

127. The thin film of claim 119 used as a Cu barrier layer in a microelectronic device.

128. A thin film of $Ti_xQ_yN_z$ inhibiting copper diffusion from a copper-containing material and formed by sputtering a sputtering target in a nitrogen atmosphere, wherein "Q" is a label for said one or more alloying elements; said target comprising Ti and one or more alloying elements having at least a 8 percent difference in atomic radii relative to titanium.

129. The thin film of claim 128 wherein $x=0.1\text{-}0.7$, $y=0.001\text{-}0.3$, and $z=0.1\text{-}0.6$.

130. The thin film of claim 128 having a thickness of from about 2 nm to about 50nm.

131. The thin film of claim 128 having a thickness of from about 2 nm to about 20nm.

132. The thin film of claim 128 further comprising an electrical resistivity of equal to or less than 300μΩ•cm.

133. The thin film of claim 128 used as a Cu barrier layer in a microelectronic device.

134. The thin film of claim 128 further comprising a mean grain size of equal to or less than 100nm, the mean grain size remaining equal to or less than 100nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

135. The thin film of claim 128 further comprising a mean grain size of equal to or smaller than 10nm, the mean grain size remaining equal to or less than 10nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

136. The thin film of claim 128 further comprising a mean grain size of equal to or smaller than 1nm, the mean grain size remaining equal to or less than 1nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

137. A thin film of $Ti_xQ_yN_zO_w$ inhibiting copper diffusion from a copper-containing material and formed by sputtering a sputtering target in the presence of a nitrogen-containing gas and an oxygen-containing gas, wherein "Q" is a label for said one or more alloying elements; said target comprising Ti and one or more alloying elements having at least a 8 percent difference in atomic radii relative to titanium.

138. The thin film of claim 137 wherein x=0.1-0.7, y=0.001-0.3, z=0.1-0.6, and w=0.0001-0.0010.

139. The thin film of claim 137 having a thickness of from about 2 nm to about 50nm.

140. The thin film of claim 137 having a thickness of from about 2 nm to about 20nm.

141. The thin film of claim 137 further comprising an electrical resistivity of equal to or lower than 300μΩ•cm.

142. The thin film of claim 137 further comprising a mean grain size of equal to or less than 100nm, the mean grain size remaining equal to or less than 100nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

143. The thin film of claim 137 further comprising a mean grain size of equal to or smaller than 10nm, the mean grain size remaining equal to or less than 10nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

144. The thin film of claim 137 further comprising a mean grain size of equal to or smaller than 1nm, the mean grain size remaining equal to or less than 1nm after the thin film is exposed to a temperature of at least about 500°C for a time of at least about 30 minutes in a vacuum anneal.

145. The $Ti_xQ_yN_zO_w$ thin film of claim 137 used as a Cu barrier layer in a microelectronic device.

146. A semiconductor construction, comprising:

a semiconductor substrate;

a material supported by the semiconductor substrate, and into which diffusion of a metal is to be alleviated;

a mass over the material and comprising the metal;

a intervening layer comprising Ti and one or more alloying elements; the intervening layer being between the mass and the material into which diffusion of the metal is to be alleviated; the one or more alloying elements at having least one of: (1) a standard electrode potential of less than about -1.0V; (2) a melting temperature of at least about 2400°C; or (3) at least a 8 percent difference in atomic radii relative to titanium; and

the intervening layer alleviating diffusion of the metal from the mass to the material relative to an amount of diffusion that would occur without the intervening layer.

147. The construction of claim 146 wherein the metal for which diffusion is to be alleviated is copper.

148. The construction of claim 146 wherein the one or more alloying elements are selected from the group consisting of Be, B, Al, Si, Ca, Sc, V, Cr, Mn, Fe, Sr, Y, Zr, Cs, Ba, La, Hf, Ta, Ce, Pr, Nd, Sm, Gd, Dy, Ho and Er.

149. The construction of claim 146 wherein the one or more alloying elements comprise Zr.

150. The construction of claim 146 wherein the one or more alloying elements comprise V.

151. The construction of claim 146 wherein the one or more alloying elements comprise Cr.

152. The construction of claim 146 wherein the one or more alloying elements comprise Mn.

153. The construction of claim 146 wherein the one or more alloying elements comprise Al.

154. The construction of claim 146 wherein the one or more alloying elements comprise B.

155. The construction of claim 146 wherein the one or more alloying elements comprise Nb.

156. The construction of claim 146 wherein the one or more alloying elements comprise Mo.

157. The construction of claim 146 wherein the one or more alloying elements comprise Hf.

158. The construction of claim 146 wherein the one or more alloying elements comprise Ta.

159. The construction of claim 146 wherein the one or more alloying elements comprise W.

160. The construction of claim 146 wherein the one or more alloying elements comprise Y.

161. The construction of claim 146 wherein the one or more alloying elements comprise Co.

162. The construction of claim 146 wherein the one or more alloying elements comprise Ni.

163. The construction of claim 146 wherein the one or more alloying elements comprise Ba.

164. The construction of claim 146 wherein the one or more alloying elements comprise La.

165. The construction of claim 146 wherein the one or more alloying elements comprise Yb.

166. The construction of claim 146 wherein the metal for which diffusion is to be alleviated is copper; and wherein the material into which copper diffusion is to be alleviated is an electrically insulative material.

167. The construction of claim 146 wherein the metal for which diffusion is to be alleviated is copper; and wherein the material into which copper diffusion is to be alleviated comprises silicon dioxide.

168. The construction of claim 146 wherein the metal for which diffusion is to be alleviated is copper; and wherein the material into which copper diffusion is to be alleviated comprises BPSG.

169. The construction of claim 146 wherein the metal for which diffusion is to be alleviated is copper; and wherein the material into which copper diffusion is to be alleviated comprises fluorinated silicon dioxide with a dielectric constant less than or equal to 3.7.

170. The construction of claim 146 wherein the metal for which diffusion is to be alleviated is copper; and wherein the material into which copper diffusion is to be alleviated comprises an insulative material with a dielectric constant less than or equal to 3.7.